

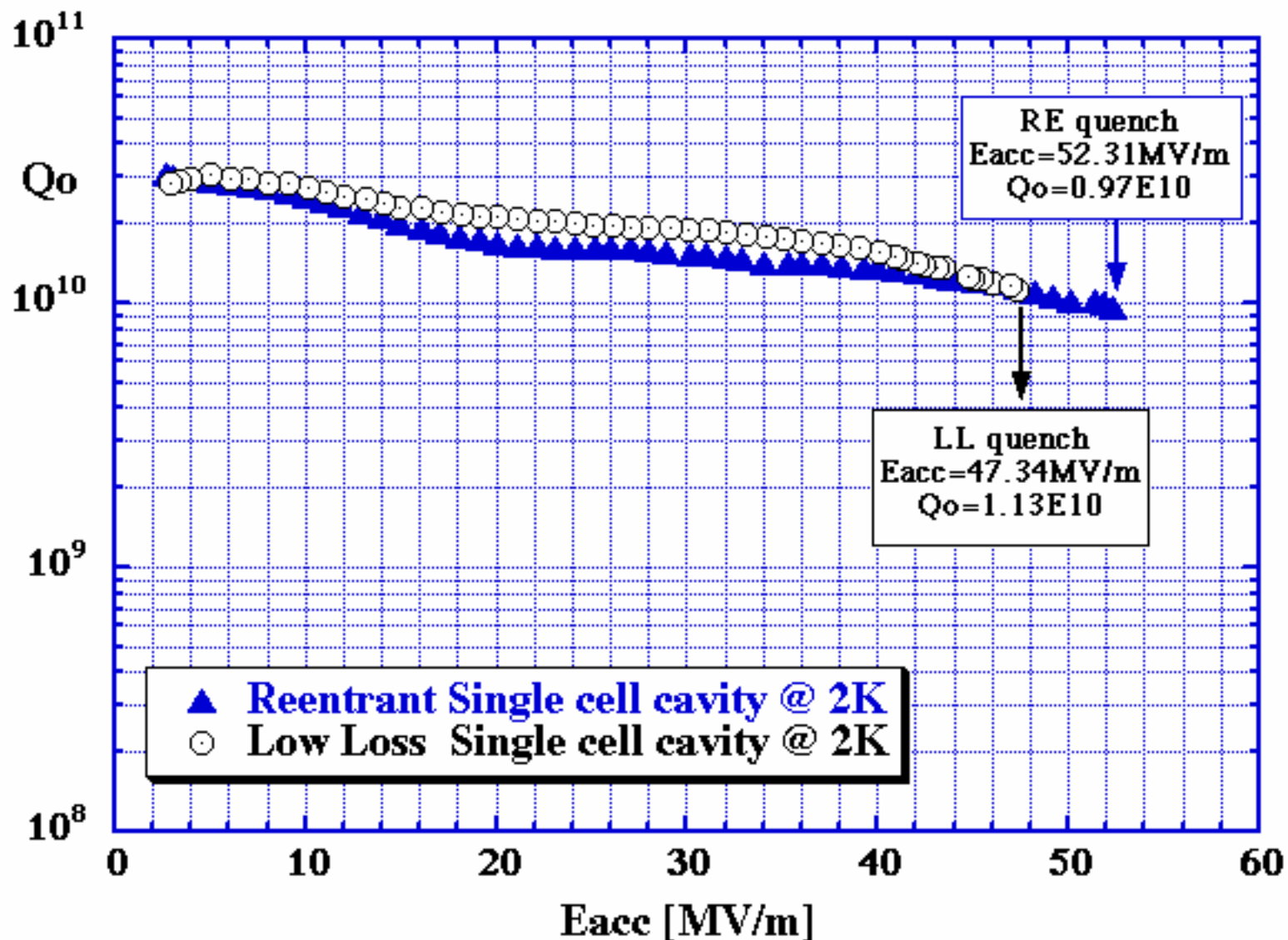
Failure report in EP system at KEK/Nomura

SMTF meeting

5 October 2005

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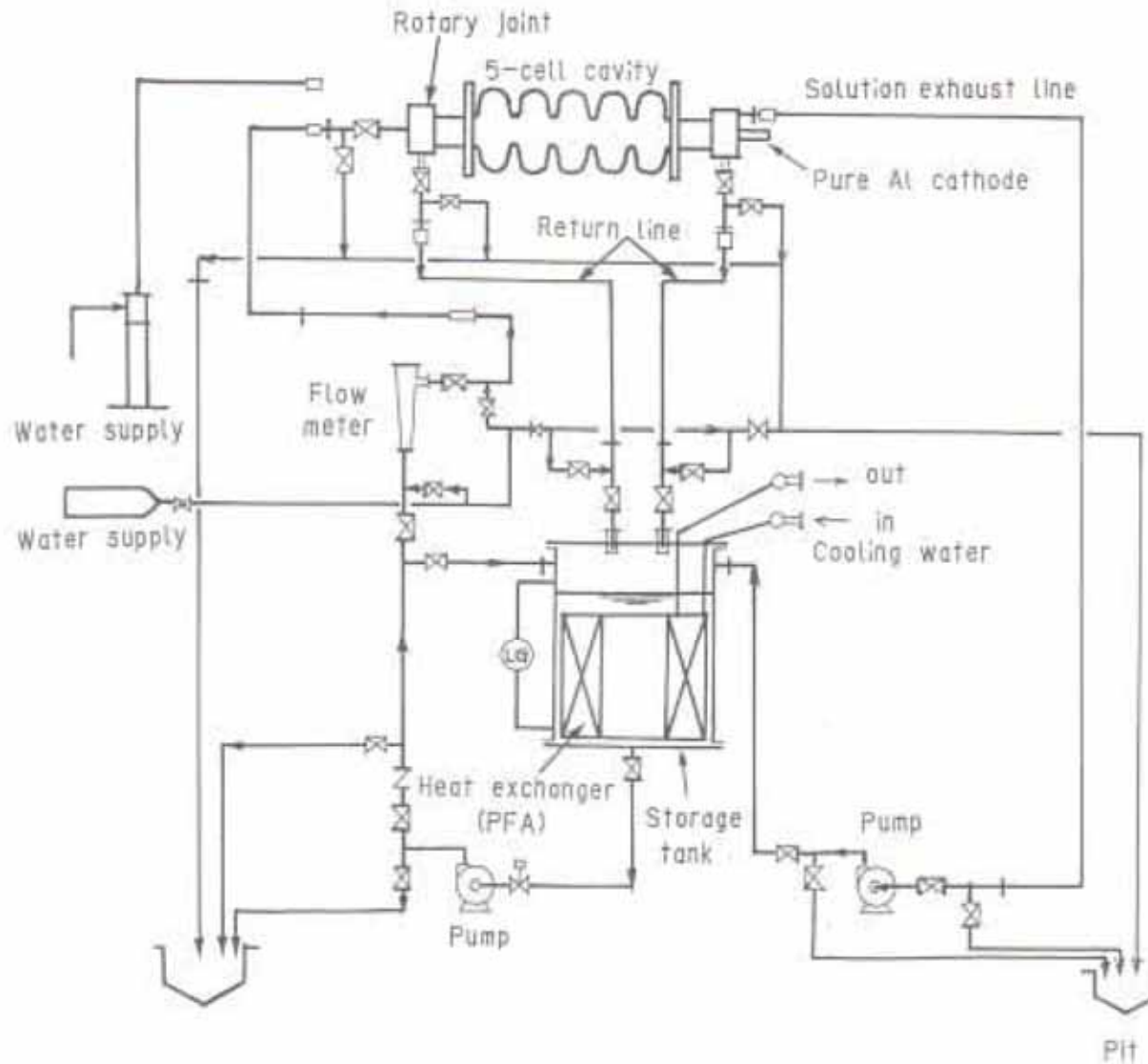
Typical RE and LL plot



Introduction

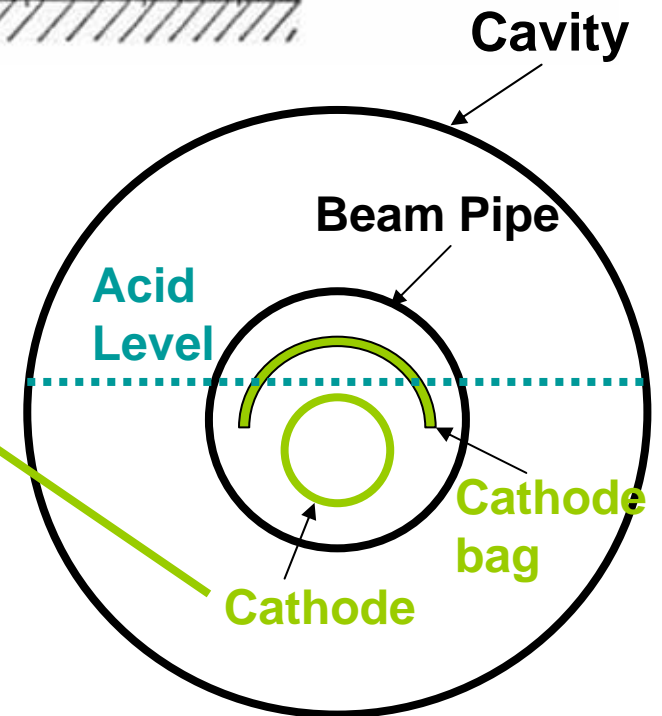
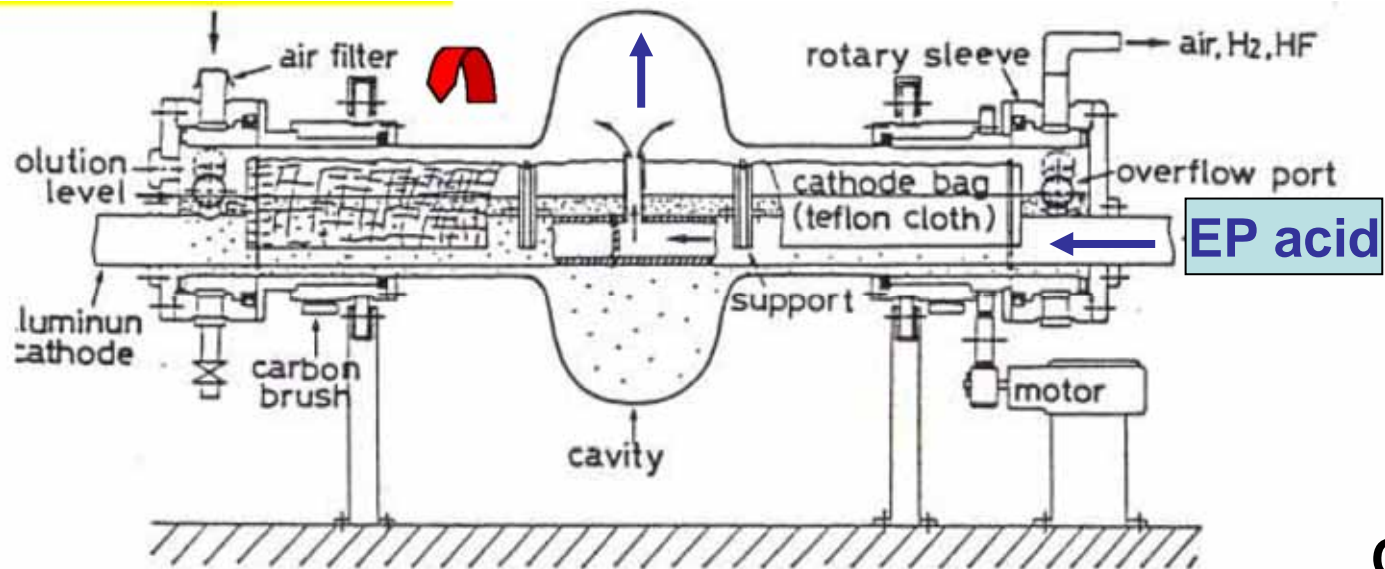
- What happened since 1st ILC WS at KEK (Nov. 2004) are reported.
- We resumed very obsolete EP facility in Nomura plating co. Operators had forgot important procedures in EP operation.
- This caused many troubles and many failures before we achieve high-gradient....
- Failures teach you much. These failures are reported in this presentation.

EP System Flow



EP system for single-cell cavity





Three problems mixed

In cavity performance

1) Field emission

2) Q-disease

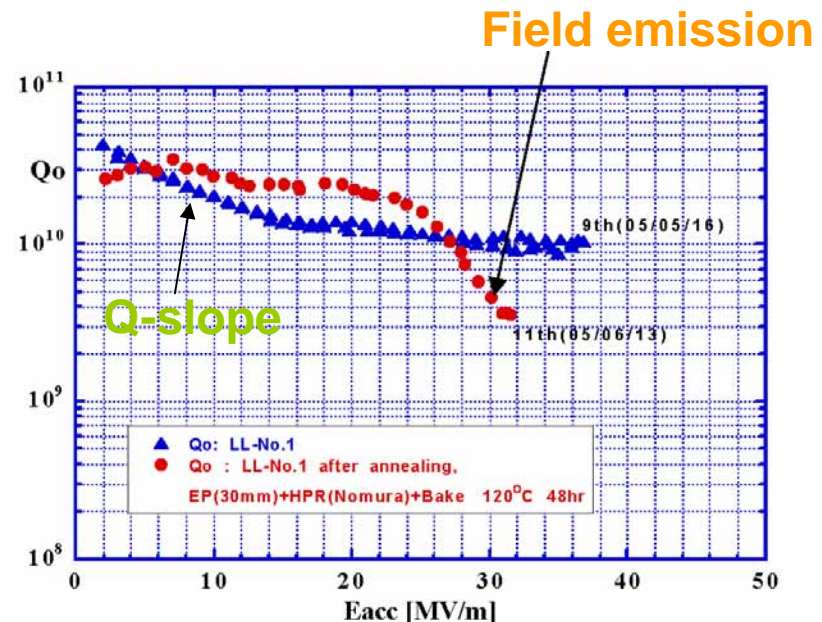
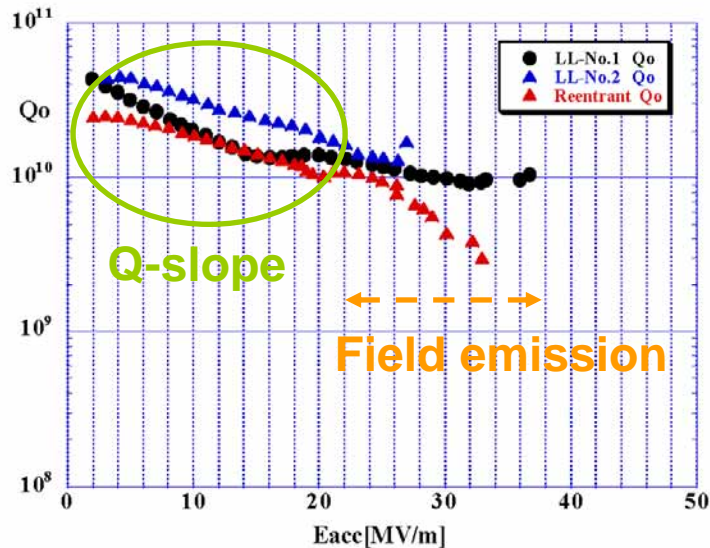
3) Q-slope at low field
(only partially solved?)

In EP operations

1) Oil contamination
in HPR water

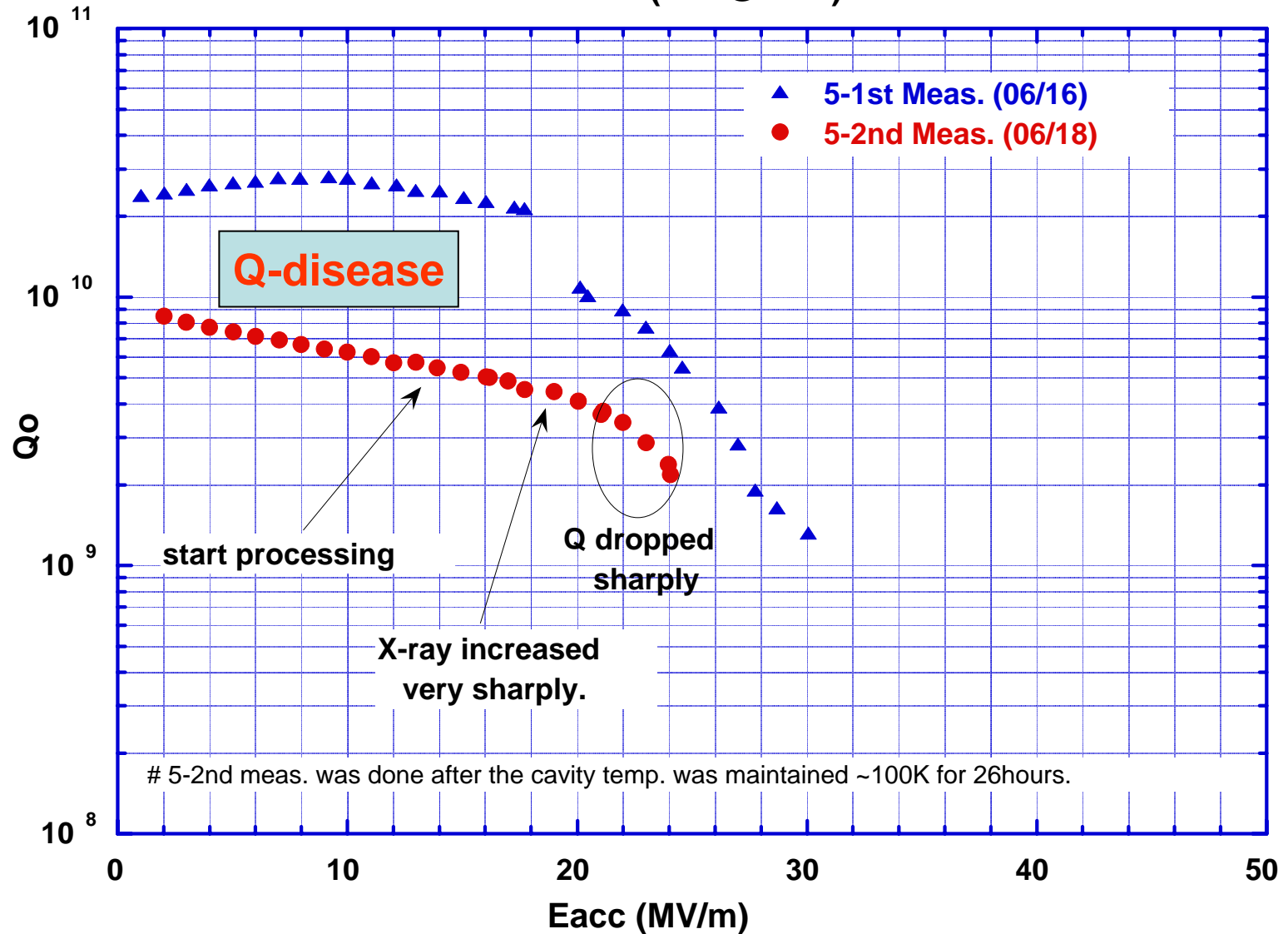
2) EP acid level
& temp. control

3) HF density in EP acid



Re-cavity 5-2nd Meas.
CP(10um)+HPR(KEK)+Baking(57H@120oC)+
H-collection (26H@100k)

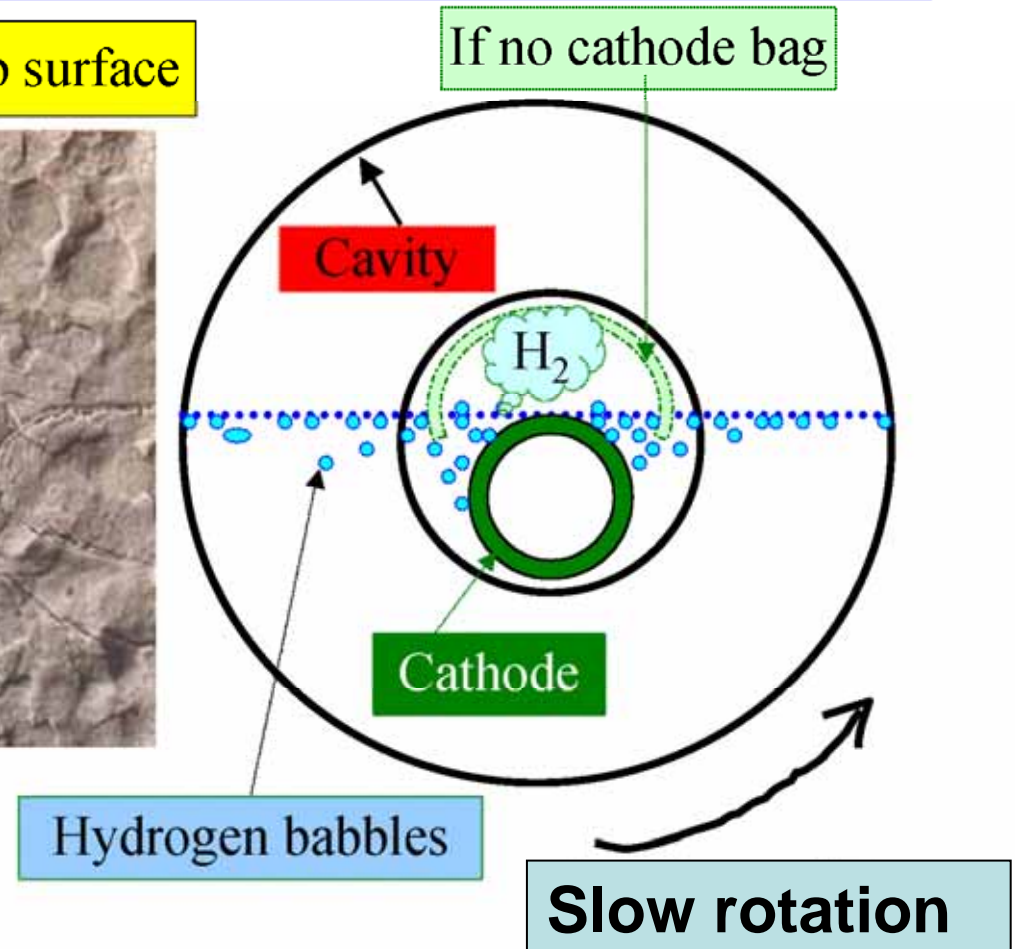
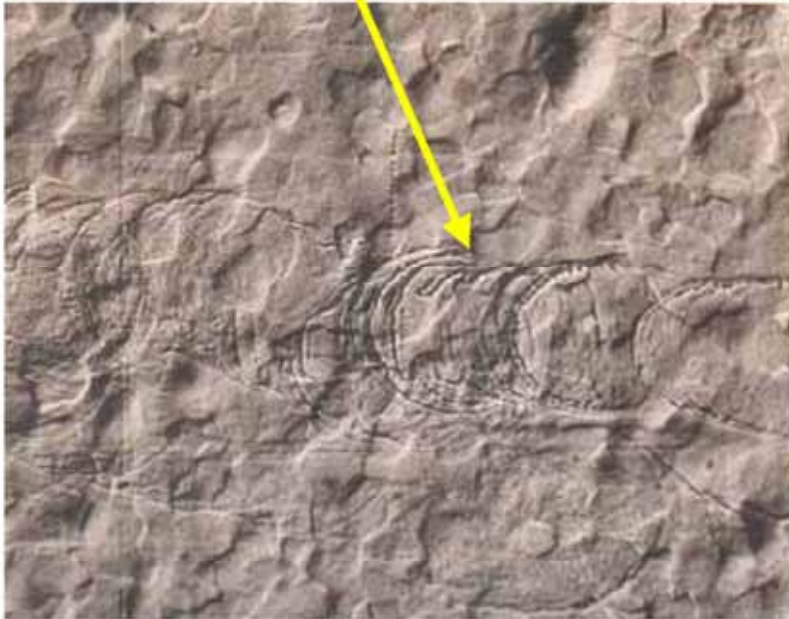
2005/06/18 Sat.



Q-disease
and
Real technical failures

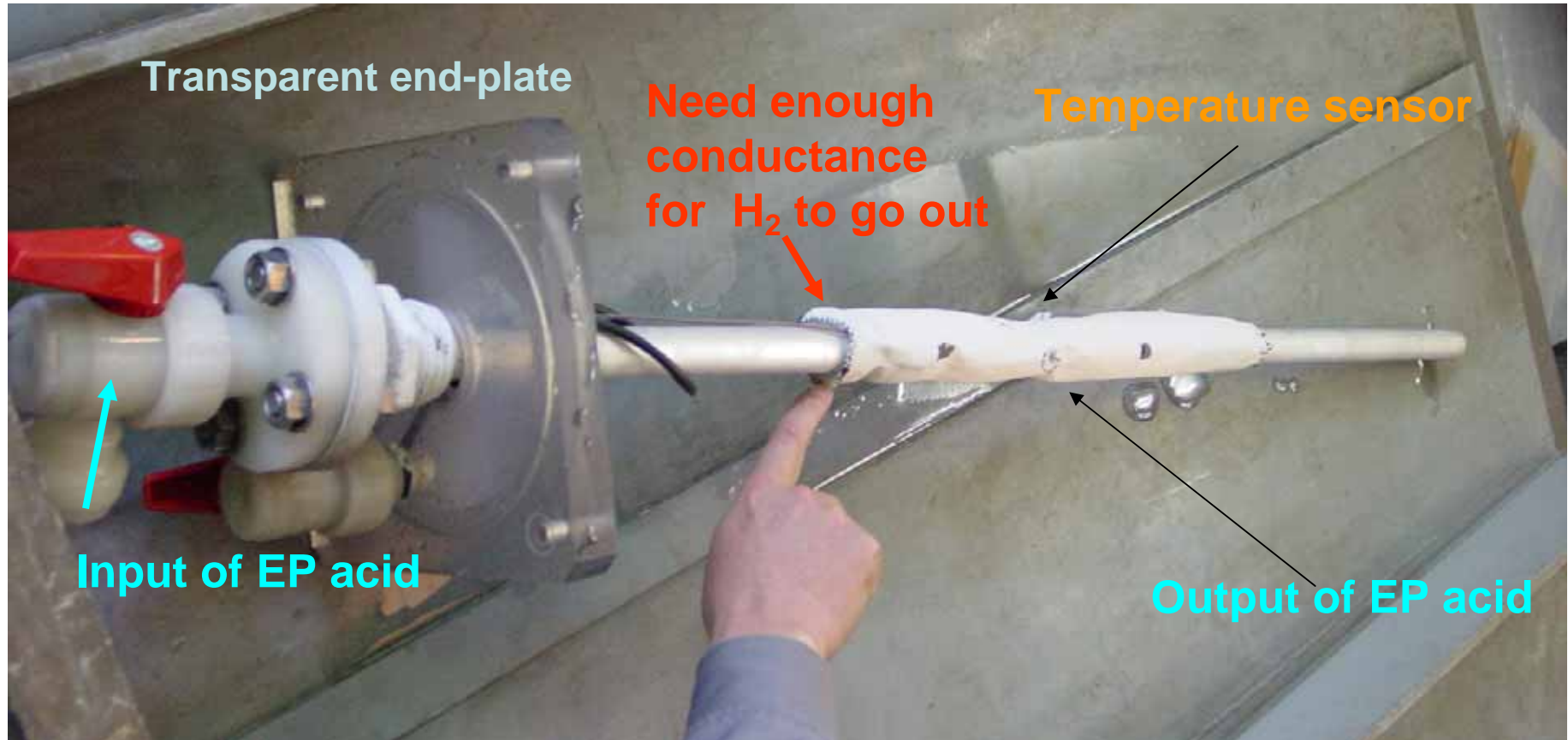
Cathode Bag

Hydrogen bubble trace on Nb surface



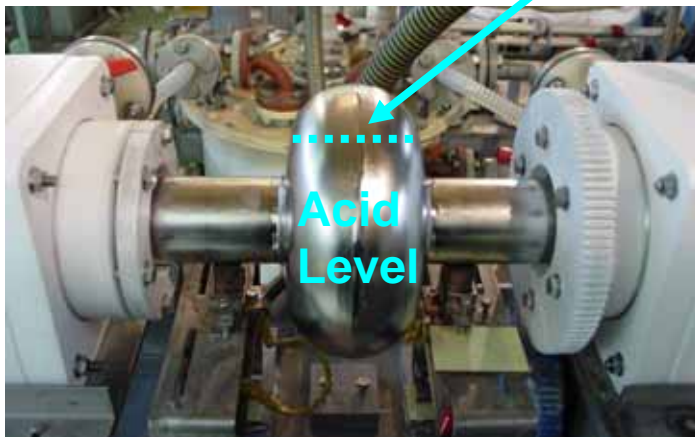
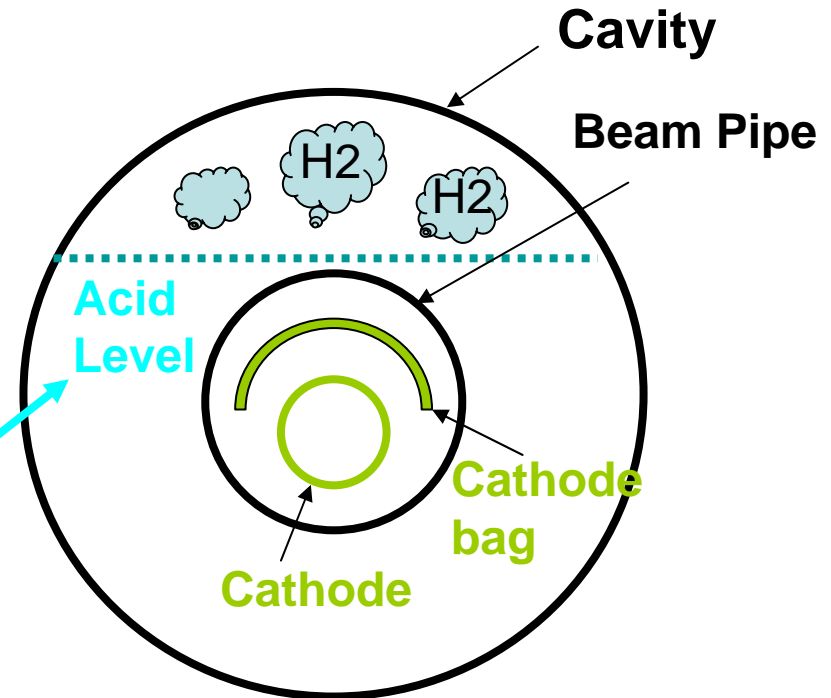
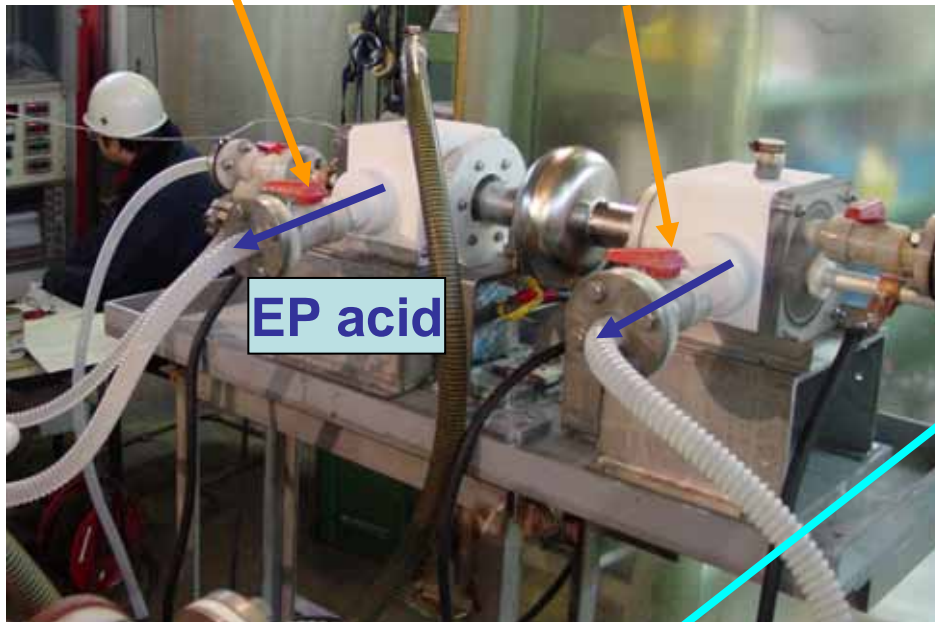
**Cathode bag was not setup properly by operator
=> Hydrogen Q-disease**

Cathode and cathode bag



EP acid level control failure

EP acid output valves for level control

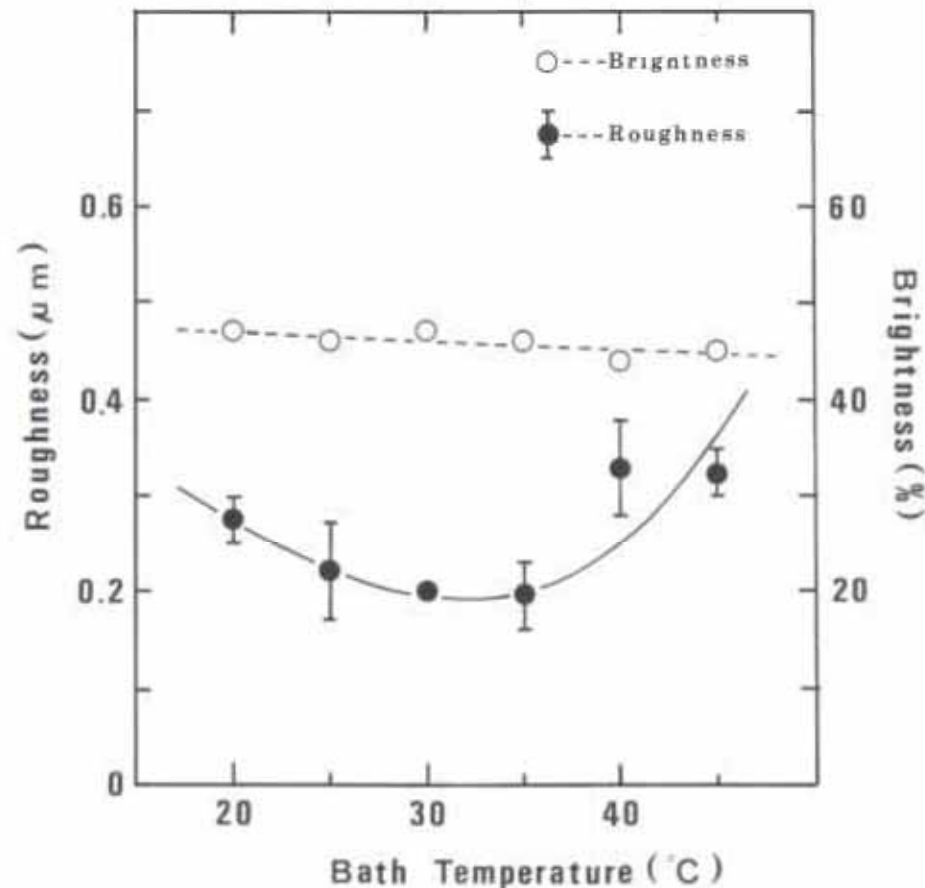


EP acid output valve was not properly controlled.



Hydrogen Q-disease

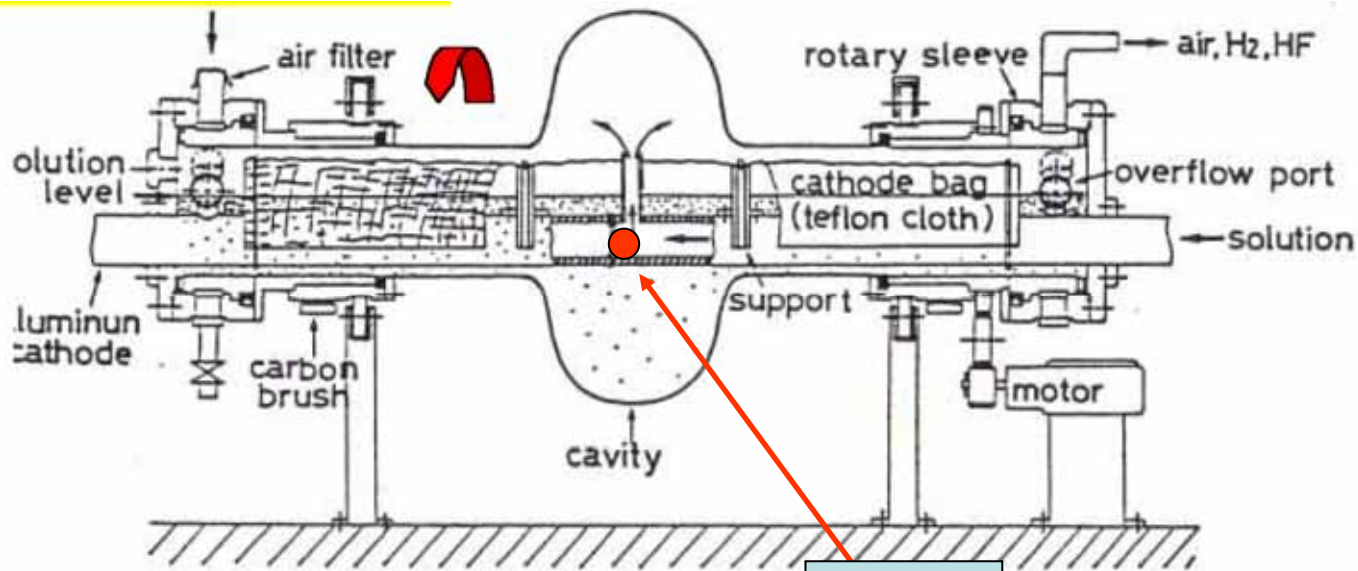
Temperature Effect on EP Finishing



$25 < T < 35^{\circ}C$

$T > 35^{\circ}C$

\Rightarrow also raises the possibility of H Q-disease

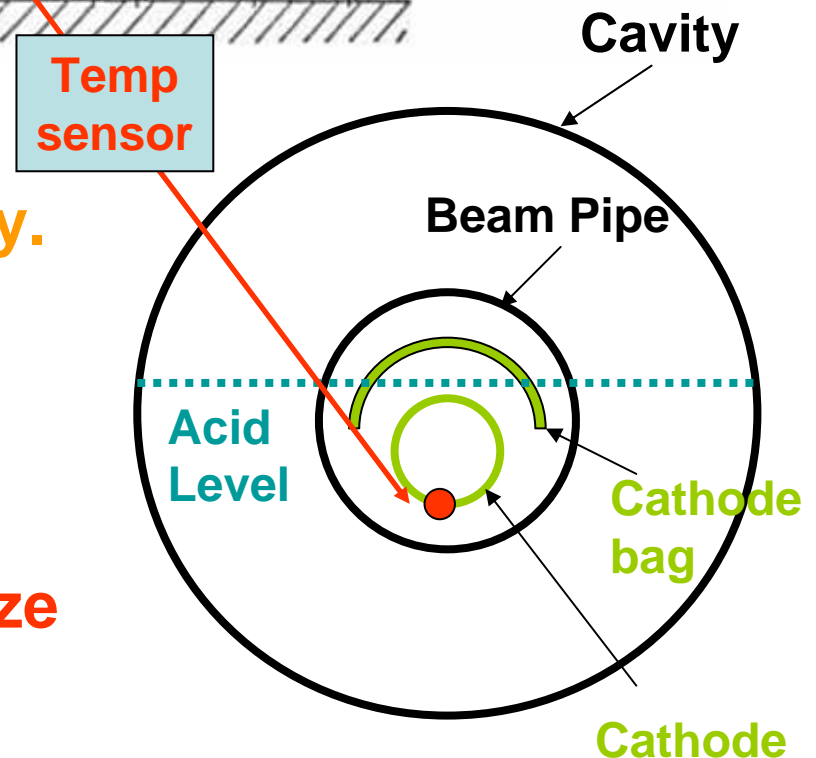


**EP acid temperature monitor
& control were not done properly.**

Related parameters:

**Voltage, Current, EP acid flow,
Reservoir tank temperature.**

**⇒ Operator forgot how to optimize
these parameter-set.**



What was learned (H Q-disease)

Cause of failure

- Operators forgot what is important in cathode bag setup, EP acid level control, and temperature control.



Current status

- Check-list of all setups and parameters are prepared.
- Re-training operators.



Recommended system

- Future plan: Automatic monitoring, temp./valve-control by computer. But not easy for EP system parts (Teflon flow-meter, valve...expensive to replace with computer-controllable parts).

Field Emission
Q-disease
Q-slope in low field

and

Real technical failures

EP acid problem

This valve should be open during EP process to pump H₂ gas.
But operator should keep this valve closed after EP process finished. Otherwise, HF escapes from this line.



Nb density
In acid from
total charge

Operator forgot to close this valve after EP process.

EP acid problem

- Operator forgot to close valve.
- HF escaped from the valve and HF density became low in EP acid.

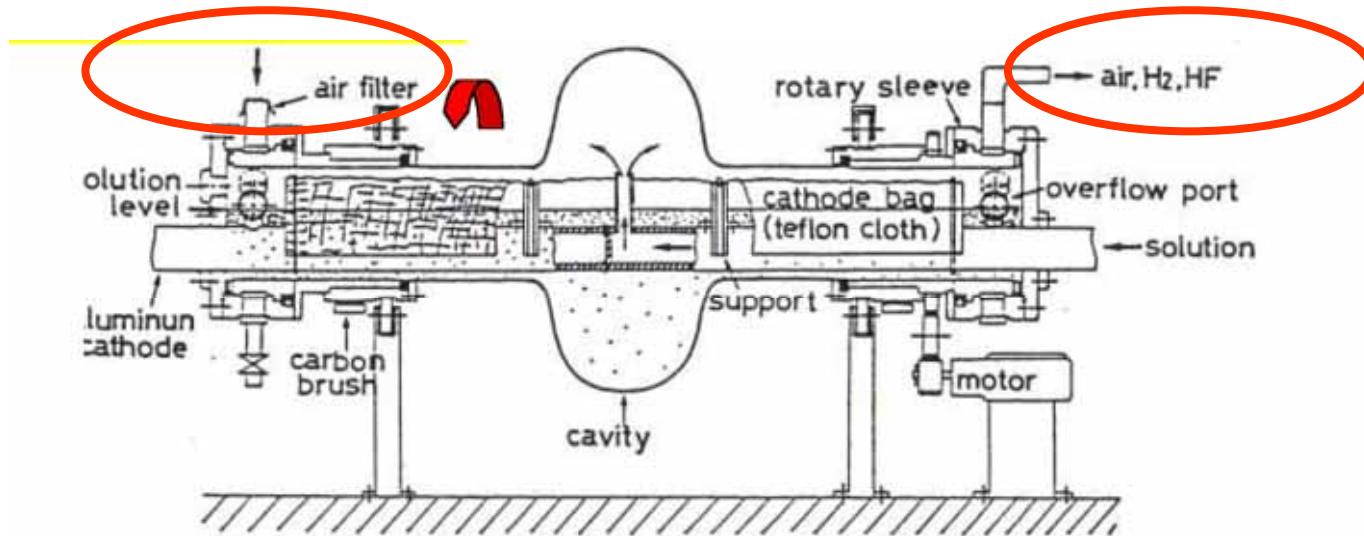


- Needed high-voltage to keep optimum current.
=> High acid temperature.
=> H absorption / surface etching.
=> q-disease / field emission / Q-slope in low field?

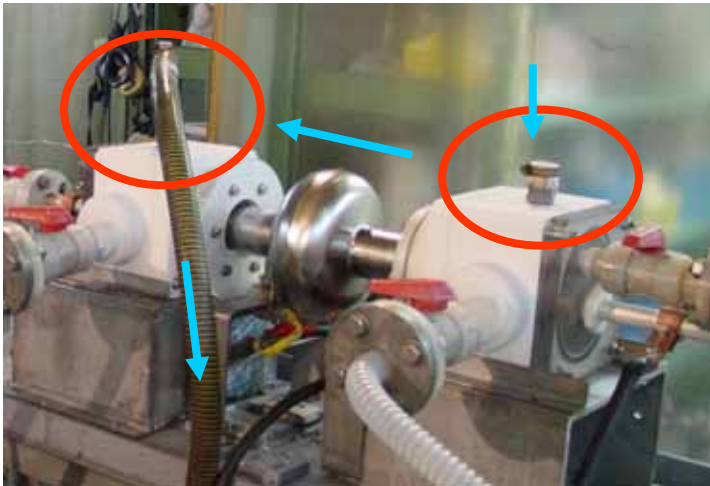


EP acid was replaced with new one.

What was learned from EP acid problem



Another air-flowing to pump H_2 gas .

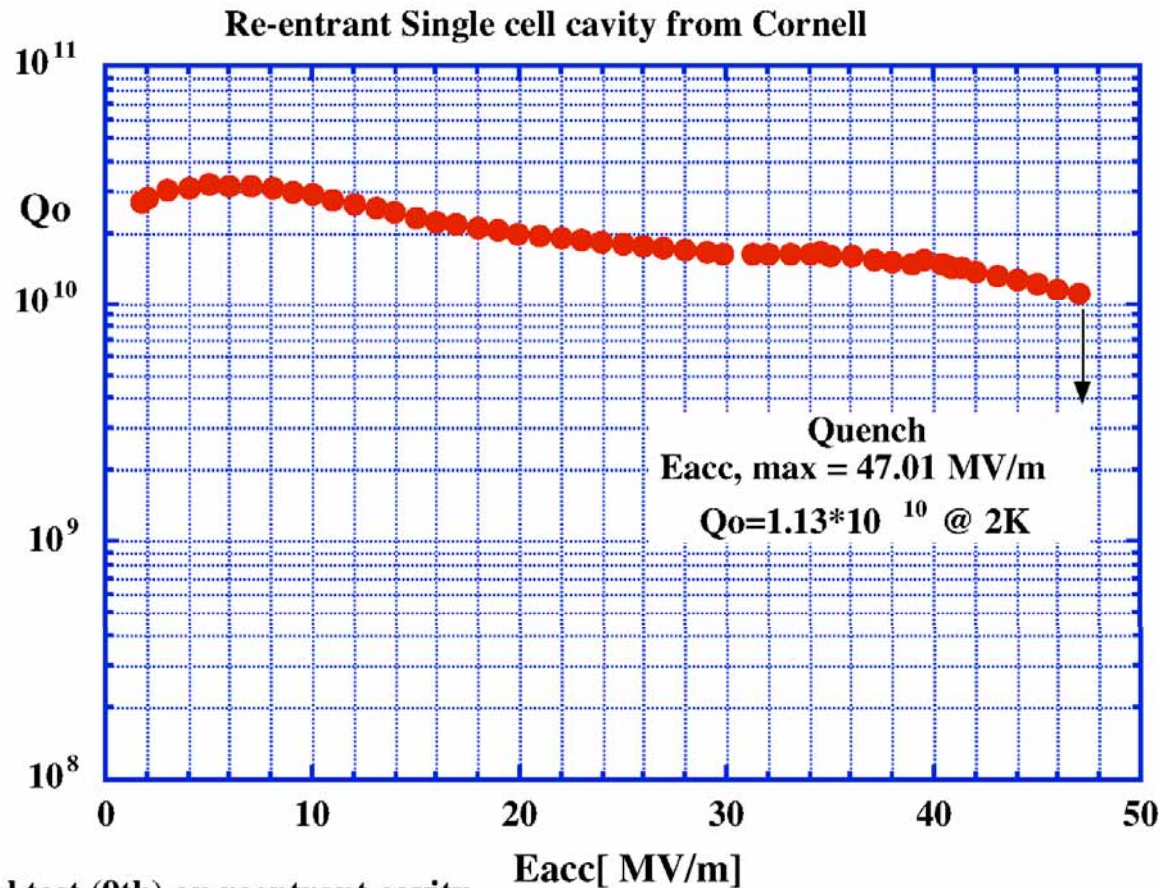


We are thinking these pumping in EP process are not affecting HF density. But Any miss-operation of H_2 -gas pumping makes EP acid lifetime shorter.



EP acid lifetime-monitoring by total-charge (Nb density in EP acid) is enough? Should we do real monitoring of HF density in EP acid? Open question.....

RE single-cell cavity achieved 47 MV/m on 30 July 2005.



: Vertical test (9th) on reentrant cavity

Re-annealed (750°C, 3hr) + EP(30μm) + HPR(Nomura, ultra-pure water) + Bake(120°C, 48hr)

EP process of 9-cell cavity



Current (400A), reservoir tank (1000 L)

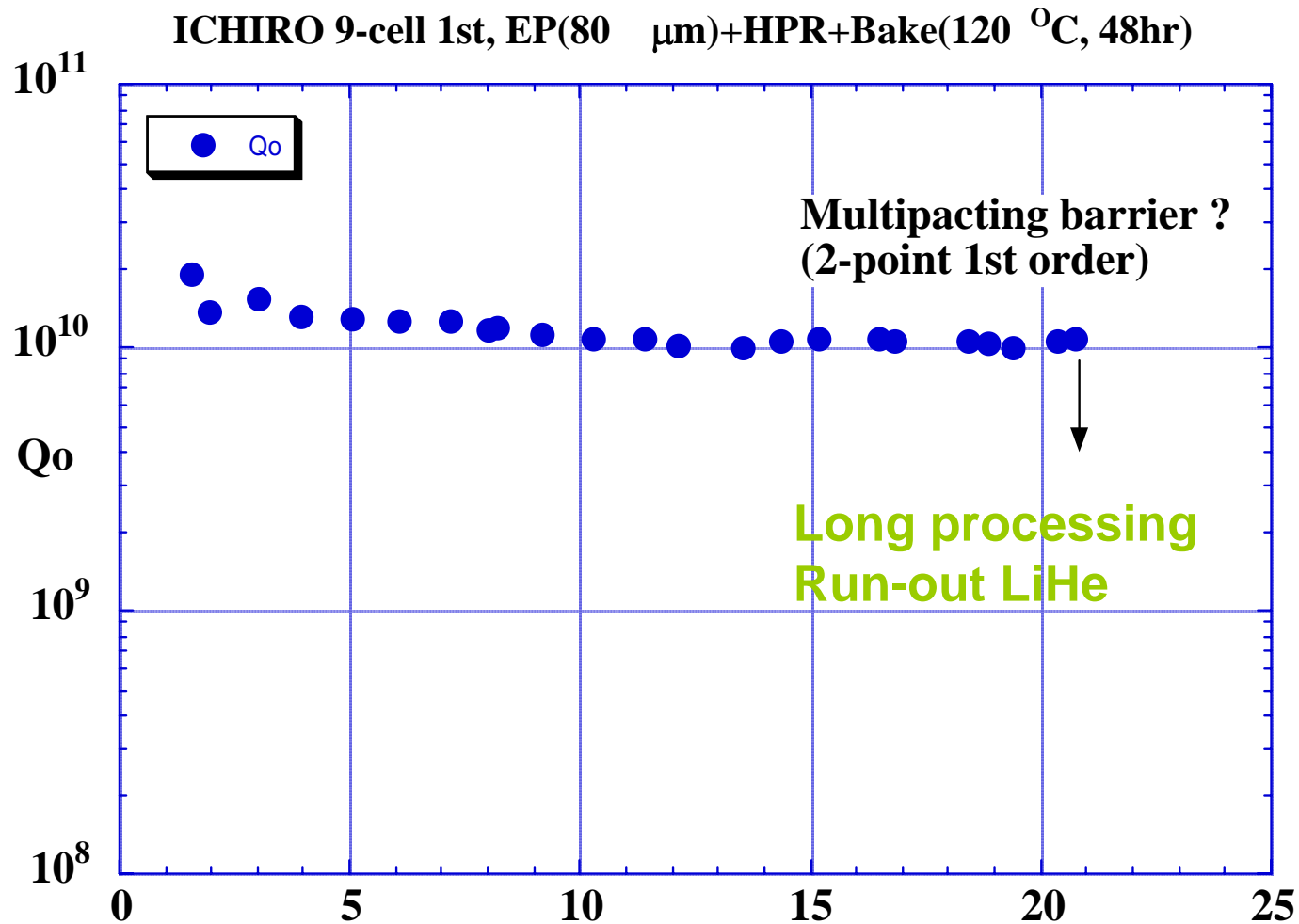


Fig.2: Vertical test result on ICHIRO 9-cell 1st cavity

The lower Q_0 value $\sim 1 \times 10^{10}$ (expected value 2×10^{10}) is due to heating at stainless flanges at both ends.

TRISTAN experience (M.P. source = S ?)

Sulfur Contamination in EP System



Brand-new Teflon tube
Heat exchange



Brand-new Teflon lining
Reservoir tank (1000L)

Restoration of
Sulfuric acid



Eduction/deposition
of sulfur around
impure materials
as a core.



After S pollution



After S pollution

Disassembled
EP system and
Cleaned up all parts
by hand.
(TRISTAN)

M.P. source is sulfur ?

- 9-cell ICHIRO cavity encountered M.P. hard barrier at 21 MV/m.
- TRISTAN experience => one of M.P. source is sulfur contamination in EP acid.
- Should we clean-up the reservoir tank (1000L) again? It is difficult.....
- Or activated charcoal filter?

Summary

- We resumed very obsolete EP facility in Nomura plating Co.
- Field emission, Q-disease, Q-slope in low field were main problems.
- Operators had forgot what is important in EP process => Main reason of failures.
- Check-list of all setups and parameters are prepared. Operators were re-trained. Then we solved most of problems.
=> Quality of operators is very important in EP process.
- Doubting sulfur contamination in EP acid. How to solve this problem is open question.